(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) Publication number : 0 393 828 B1

(12) EUROPEAN PATENT SPECIFICATION

(45) Date of publication of patent specification : 06.10.93 Bulletin 93/40

(51) Int. Cl.[5] : G01L 1/25, G01L 25/00, G01L 5/00

(21) Application number : 90302569.0

(22) Date of filing : 09.03.90

(54) A method and apparatus for testing the response of a stress wave sensor.

(30) Priority : 21.04.89 GB 8909155

(43) Date of publication of application : 24.10.90 Bulletin 90/43

(45) Publication of the grant of the patent : 06.10.93 Bulletin 93/40

(84) Designated Contracting States : AT BE CH DE DK ES FR GB IT LI LU NL SE

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Description

The present invention relates to a method and an apparatus for testing the response of a stress wave sensor or acoustic emission sensor.

Stress wave sensors are used for monitoring of machinery, processes or structures, and it is desirable for stress wave sensors to be installed for long term monitoring of machinery, processes or structures. In such long term monitoring of machinery, processes or structures, it is highly desirable to have a procedure to confirm that the stress wave sensor is working satisfactorily. It is necessary to confirm that the stress wave transducer and amplifier which make up part of the stress wave sensor are functioning satisfactorily.

Common methods used to confirm the operation of acoustic emission sensors are the use of a breaking pencil lead, a gas jet, or a periodically applied stress wave pulse from another electrically excited acoustic emission transducer. However such methods require an operator to check the acoustic emission sensor is working satisfactorily.

GB1254219 discloses testing of the circuitry of a vibration frequency and amplitude by injecting signals of known frequency and amplitude by a test oscillator. The test oscillator is electrically connected to the vibration monitoring system at a point electrically between a transducer and an amplifier.

The present invention seeks to provide a novel method and apparatus for testing the response of a stress wave sensor.

Accordingly the present invention provides a method of testing the response of a stress wave sensor, the stress wave sensor comprising a transducer and an amplifier arranged electrically in series, the method comprising supplying to the sensor at a point electrically between the transducer and the amplifier at least one first electrical pulse, the first electrical pulse being of a relatively large amplitude such that it causes an operative transducer to oscillate, an operative transducer caused to oscillate by the at least one first electrical pulse generating an additional electrical pulse, supplying first electrical pulse and any additional electrical pulse generated by the transducer to the amplifier, an operative amplifier amplifying the supplied first electrical pulse and any additional electrical pulse to produce an output signal, determining from the output signal of the amplifier if any one or more of the transducer and amplifier are not operating satisfactorily, an inoperative amplifier not amplifying the supplied first electrical pulse and any additional electrical pulse and not producing an output signal, the lack of an output signal from the amplifier indicating that the amplifier is inoperative, supplying a second electrical pulse to the sensor at the point electrically between the transducer and the amplifier, the second electrical pulse being of relatively small predetermined amplitude such that it does not saturate the amplifier, supplying the second electrical pulse to the amplifier and determining from the output signal of the amplifier corresponding to the second electrical pulse the gain of the amplifier.

Accordingly the present invention also provides an apparatus for testing the response of a stress wave sensor, the stress wave sensor comprising a transducer and an amplifier arranged electrically in series, the apparatus comprising a pulser arranged to be electrically connected to the stress wave sensor at a point electrically between the transducer and the amplifier, the pulser being arranged to supply at least one electrical pulse to the stress wave sensor, the supplied electrical pulse being of relatively large amplitude such that it causes an operative transducer to oscillate, an operative transducer caused to oscillate by the at least one first electrical pulse generating an additional electrical pulse, the supplied electrical pulse and any additional electrical pulse generated by the transducer being supplied to the amplifier, an operative amplifier amplifying the supplied electrical pulse and the additional electrical pulse to produce an output signal, means to determine from the output signal of the amplifier if any one or more of the transducer and amplifier are not operating satisfactorily, an inoperative amplifier not amplifying the supplied electrical pulse and any additional electrical pulse and not producing an output signal, the lack of an output signal from the amplifier indicating that the amplifier is inoperative, the pulser is arranged to supply at least one second electrical pulse to the stress wave sensor, the second electrical pulse being of relatively small predetermined amplitude such that it does not saturate the amplifier, the second electrical pulse being supplied to the amplifier and means to determine from the output signal of the amplifier corresponding to the second electrical pulse the gain of the amplifier.

The pulser may comprise a square wave generator arranged to supply a square wave signal to a first transistor, the first transistor being switched on when the input square wave is relatively high, the first transistor being electrically connected to a supply voltage, the first transistor being electrically connected in series to a second transistor via a capacitor, the second transistor being electrically connected to the supply voltage, the second transistor being switched on when the first transistor is switched on to produce the first electrical pulse, the first electrical pulse being supplied from the second transistor to the stress wave sensor, the capacitor being charged up to switch off the second transistor.

The first transistor may be switched off when the input square wave is relatively low, the first transistor producing the second electrical pulse which is supplied to the stress wave sensor via a second capacitor, a diode being arranged to set the predetermined

amplitude of the second electrical pulse.

The present invention will be more fully described by way of example with reference to the accompanying drawings, in which:-

Figure 1 is an electrical circuit representative of a stress wave sensor according to the present invention.

Figure 2 is a graph of voltage against time showing first and second electrical pulses supplied to the stress wave sensor.

Figure 3 is a graph of voltage against time showing the output envelope from an operative stress wave sensor as a result of the first and second electrical pulses.

Figure 4 is a graph of voltage against time showing the output envelope from one type of inoperative stress wave sensor as a result of the first and second electrical pulses.

Figure 5 is a graph of voltage against time showing the output envelope from a further type of inoperative stress wave sensor as a result of the first and second electrical pulses.

Figure 6 is a graph of voltage against time showing the output envelope from a further type of inoperative stress wave sensor as a result of the first and second electrical pulses.

An apparatus 24 for testing the response of a stress wave sensor 10 is shown in Figure 1. The stress wave sensor 10 comprises a piezoelectric type stress wave transducer 12 and an amplifier 20, electrically connected in series. A resistor 14 is positioned electrically in series between the transducer 12 and the amplifier 20 and diodes 16,18 are connected in parallel between the input to the transducer and earth to protect the amplifier 20. The amplifier 20 has an output terminal 22 which may be connected to further electronic circuitry, for example filters, processors, displays. In this example the amplifier 20 is connected to processors which rectify and envelope the amplifier output signal.

The apparatus 24 for testing the response of the stress wave sensor 10 comprises a pulser circuit which converts an input square wave into a series of output pulses. The pulser circuit is arranged to produce a first electrical pulse which has a relatively large amplitude, and a second electrical pulse which has a relatively small amplitude. The pulser circuit 24 comprises an input terminal 26 which is arranged to be supplied with a square wave electrical signal. A five volt square wave generator is suitable for this purpose. The pulser circuit 24 also comprises a supply voltage VCC.

The first relatively large electrical pulse occurs when the input square wave electrical signal goes high, this signal is supplied to the base terminal 34 of an NPN transistor 32, <u>via</u> a resistor 28, causing the transistor 32 to be switched on. The collector terminal 36 of the transistor 32 is connected to the supply voltage VCC <u>via</u> a resistor 40, the emitter terminal 38 of the transistor 32 is connected to earth 42 directly and the base terminal 34 of the transistor 32 is also connected to earth 42 <u>via</u> a resistor 30. When transistor 32 switches on, the voltage on its collector terminal 36 drops rapidly from the supply voltage VCC potential.

The collector terminal 36 of the transistor 32 is connected to the base 46 of a PNP transistor 44 <u>via</u> a capacitor 52 and a resistor 54 arranged in series. The emitter terminal 48 of the transistor 44 is connected to the supply voltage VCC and the collector terminal 50 of the transistor 44 is connected to a position between resistors 56 and 58 which form a voltage divider. Resistor 56 is connected to earth 42 and resistor 50 is connected to an output terminal 60 of the pulser circuit 24. When the voltage on the collector terminal 36 of transistor 32 drops, the voltage on the side of the capacitor 52 remote from transistor 32 is initially pulled down causing the transistor 44 to be switched on, this produces a positive first electrical pulse which is supplied to the output terminal 60. The amplitude of the first electrical pulse is almost equal to the supply voltage VCC. The capacitor 52 then charges up through a resistor 62 causing the transistor 44 to be switched off and the first electrical pulse to be terminated.

The second relatively small electrical pulse occurs when the input square wave electrical signal goes low, this signal is again supplied to the base terminal 34 of the NPN transistor 32, causing the transistor 32 to be switched off. The collector terminal 36 of the transistor 32 is connected to the output terminal 60 <u>via</u> a capacitor 64 and a resistor 66 arranged electrically in series. The resistor 66 and a resistor 68 are arranged to form a voltage divider, the resistor 68 also being connected to earth 42. When transistor 32 switches off, the voltage on its collector terminal 36 rises to the supply voltage VCC potential. This causes the side of the capacitor 64 remote from transistor 32 to rise to 5.6 volts, which is set by a Zener diode 70 connected to a position between the resistor 66 and the capacitor 64 and the earth 42. The voltage divider formed by the resistors 66 and 68 supplies a second electrical pulse with a voltage considerably smaller, for example 100 times, than 5.6 volts to the output terminal 60. The capacitor 36 then discharges through resistors 66 and 68 causing the voltage across the diode 70 and therefore the voltage supplied to the output terminal 60 to fall.

Thus the pulser circuit 24 continuously supplies alternate first and second electrical pulses to the output terminal 60 for as long a period as a square wave input is supplied to input terminal 26.

The pulser circuit 24 is connected to the stress wave sensor 10 such that the output terminal 60 of the pulser circuit 24 is electrically connected to the stress wave sensor 10 at a point electrically between

the transducer 12 and the amplifier 20. The pulser circuit 24 supplies alternate first and second electrical pulses to the stress wave sensor 10 to test the response of the stress wave sensor 10.

The first electrical pulse, of relatively large amplitude, is supplied to the stress wave sensor 10 and is thus supplied to both the transducer 12 and the amplifier 20. The first electrical pulse excites the transducer 12 causing an operative transducer 12 to oscillate and to regenerate an additional electrical signal which is supplied to the amplifier 20. The first electrical pulse is amplified by the amplifier 20, and because the first electrical pulse is of relatively large amplitude the output from amplifier 20 at output terminal 22 corresponding to the first electrical pulse will be of relatively high level or magnitude. The additional electrical signal supplied from the operative transducer 12 is also amplified by the amplifier 20. Because of conversion losses in the transducer 12 as the first electrical pulse changes from electrical to mechanical oscillation and back from mechanical oscillation to an electrical signal the amplified additional electrical signal is at a much lower level than the direct first electrical pulse. The amplifier 20 is arranged to be sufficiently sensitive to detect the additional electrical signal and consequently the first electrical pulse is of such a magnitude that it electrically saturates the amplifier 20 i.e. the amplified signal is clipped.

It is possible to detect from the first electrical pulse that the transducer 12 is still operative and that the amplifier is still operative, and that there has been no change in the overall stress wave sensor operation. Referring to Figures 2,3 and 4 as a result of the first electrical pulse 60 and second electrical pulse 62 there are envelope signals 64 and 70 from the amplifier 20 after rectification and enveloping by the processor.

In Figure 3 the response for an operative stress wave sensor 10 is shown, the output envelope signal 64 comprises a first portion 66 and a second portion 68. The first portion 66 corresponds to the first electrical pulse received directly by the amplifier 20, and this portion has been clipped. The second portion 68 corresponds to the additional electrical signal generated by the excitation of the transducer 12 by the first electrical signal 60. The area under the second portion 68 gives a measure of the sensitivity of the transducer 12. As a result of the second electrical pulse 62 there is an output envelope signal 70 from the amplifier 20 after rectification and enveloping by the processor. The second electrical pulse 62 is of predetermined amplitude such that it is possible to determine the gain of the amplifier 12, by measuring the peak of output envelope signal 70. It is therefore possible to detect from the second electrical pulse the gain of the amplifier, and as a result of knowing the gain of the amplifier it is then possible to determine any change in the sensitivity of the transducer i.e. the portion 68 is dependent upon the transducer sensitivity and also upon the gain of the amplifier. For example a reduction in the portion 68 may result from a reduction in transducer sensitivity, a reduction in amplifier gain or a combination of the two. The overall response of the stress wave sensor 10 is proportional to the gain of the amplifier and the square of the transducer sensitivity. The second electrical pulse is therefor important in enabling the correction of the stress wave sensor operation, for example by adjusting the gain of the amplifier or adjusting the transducer.

In Figure 4 a response is shown for a stress wave sensor in which the transducer is inoperative. The output signal 64B comprises a first portion 66B only, which corresponds to the first electrical pulse received directly by the amplifier 20. The amplifier 20 does not receive an additional electrical signal because the transducer is inoperative. The output signal magnitude 70B indicates the gain of the amplifier 20. This indicates that the transducer may need replacing because there is no additional electrical signal from the transducer.

In Figure 5 a response is shown for a stress wave sensor in which the amplifier has reduced gain. The output signal 64C comprises a first portion 66C which corresponds to the first electrical pulse and a second portion 68C which corresponds to the electrical pulse from the transducer. However the first portion 66C is not clipped in this example because the gain is very small, and in consequence the second portion 68C is difficult to detect from the decay of the first portion 66C. The output signal 70C corresponds to the second electrical pulse, and this is of very small peak amplitude which indicates the gain of the amplifier is relatively small.

In Figure 6 a response is shown for a stress wave sensor in which the transducer has reduced sensitivity. The output signal 64D comprises a first portion 66D which corresponds to the first electrical pulse and a second portion 68D which corresponds to the electrical pulse from the transducer. The first portion 66D is clipped, because the gain of the amplifier is large, but the area under the second portion 68D is very small which points towards a reduction in the transducer sensitivity. The output signal 70D corresponds to the second electrical signal of predetermined amplitude, and this is an acceptable range of peak amplitudes, and indicates that the gain of the amplifier is satisfactory and thus that the amplifier is operating satisfactorily. In view of the output signal 70D it can be confirmed that the transducer sensitivity has reduced.

The pulser circuit 24 provides a testing feature for stress wave sensors which is of relatively low cost and which does not require an operator, and enables long term unattended monitoring of machinery or processes in which it can be confirmed that the stress wave

sensor is working satisfactorily.

A pulser circuit may be arranged to supply the first and second electrical pulses in any order to the stress wave sensor, and more than one electrical pulse and second electrical pulse may be supplied to the stress wave sensor. The pulser circuit may be arranged to automatically conduct the testing of the stress wave sensor when the detected intensity, or level, in the monitoring mode of the stress wave sensor falls below a predetermined intensity or level.

Claims

1. A method of testing the response of a stress wave sensor, the stress wave sensor (10) comprising a transducer (12) and an amplifier (20) arranged electrically in series, the method comprising supplying to the sensor (10) at a point electrically between the transducer (12) and the amplifier (14) electrical pulses characterised in that at least one first electrical pulse (60), having a relatively large amplitude is supplied such that it causes the operative transducer (12) to oscillate, the operative transducer (12) caused to oscillate by the at least one first electrical pulse generating an additional electrical pulse, supplying the first electrical pulse and any additional electrical pulse generated by the transducer (12) to the amplifier (20), the operative amplifier (20) amplifying the supplied first electrical pulse and any additional electrical pulse to produce an output signal (64), determining from the output signal (64) of the amplifier (20) if any one or more of the transducer (12) and amplifier (20) are not operating satisfactorily, the inoperative amplifier (20) not amplifying the supplied first electrical pulse and any additional electrical pulse and not producing an output signal, the lack of an output signal from the amplifier (20) indicating that the amplifier (20) is inoperative,

   supplying a second electrical pulse (62) to the sensor (10) at the point electrically between the transducer (12) and the amplifier (20), the second electrical pulse (62) being of relatively small predetermined amplitude such that it does not saturate the amplifier (20), supplying the second electrical pulse (62) to the amplifier (62) and determining from the output signal (70) of the amplifier (20) corresponding to the second electrical pulse (62) the gain of the amplifier (20).

2. A method of testing the response of a stress wave sensor as claimed in claim 1 in which the gain of the amplifier (20) is adjusted when the output signal (70) of the amplifier (20) corresponding to the second electrical pulse (62) indicates the gain of the amplifier (20) is less than a predetermined value.

3. A method of testing the response of a stress wave sensor as claimed in claim 1 or claim 2 in which the gain of the amplifier (20) is adjusted when the output signal (64) of the amplifier (20) corresponding to the first electrical pulse (60) indicates the sensitivity of the transducer (12) has reduced.

4. A method of testing the response of a stress wave sensor as claimed in any of claims 1 to 3 in which the output signals (64,70) are enveloped.

5. A method of testing the response of a stress wave sensor as claimed in claim 4 in which the peak amplitude of the enveloped output signal (70) of the amplifier (20) corresponding to the second electrical pulse (62) is measured.

6. A method of testing the response of a stress wave sensor as claimed in claim 3 or claim 4 in which the area under the enveloped output signal (64) of the amplifier (20) corresponding to the additional electrical pulse (60) is measured.

7. An apparatus for testing the response of a stress wave sensor (10), the stress wave sensor (10) comprising a transducer (12) and an amplifier (20) arranged electrically in series, the apparatus comprising a pulser (24) arranged to be electrically connected to the stress wave sensor (10) at a point electrically between the transducer (12) and the amplifier (20), the pulser (24) being arranged to supply electrical pulses to the stress wave sensor (10), characterised in that the pulser (24) is arranged to supply at least one first electrical pulse of relatively large amplitude such that it causes the operative transducer (12) to oscillate, the operative transducer (12) caused to oscillate by the at least one electrical pulse generating an additional electrical pulse, the supplied first electrical pulse and any additional electrical pulse generated by the transducer (12) being supplied to the amplifier (20), the operative amplifier (20) amplifying the supplied electrical pulse and the additional electrical pulse to produce an output signal, means to determine from the output signal of the amplifier (20) if any one or more of the transducer (12) and amplifier (20) are not operating satisfactorily, the inoperative amplifier (20) not amplifying the supplied electrical pulse and any additional electrical pulse and not producing an output signal, the lack of an output signal from the amplifier (20) indicating that the amplifier (20) is inoperative, the pulser (24) is arranged to supply at least one second electrical pulse of relatively small predetermined amplitude

such that it does not saturate the amplifier (20), the second electrical pulse being supplied to the amplifier (20) and means to determine from the output signal of the amplifier (20) corresponding to the second electrical pulse the gain of the amplifier (20).

8. An apparatus as claimed in claim 7 in which a means to adjust the gain of the amplifier is arranged to increase the gain of the amplifier (20) when the means to determine the gain of the amplifier from the output signal of the amplifier (20) corresponding to the second electrical pulse indicates the gain of the amplifier (20) is less than a predetermined value.

9. An apparatus as claimed in claim 8 in which the means to adjust the gain of the amplifier is arranged to increase the gain of the amplifier (20) when the means to determine if any one or more of the transducer and amplifier are not operating satisfactorily indicates the sensitivity of the transducer (12) has reduced.

10. An apparatus as claimed in any of claims 7 to 9 in which a processor envelopes the output signals.

11. An apparatus as claimed in claim 10 in which the processor measures the peak amplitude of the enveloped output signal of the amplifier corresponding to the second electrical pulse.

12. An apparatus as claimed in claim 10 or claim 11 in which the processor measures the area under the enveloped output signal of the amplifier corresponding to the additional electrical pulse.

13. An apparatus as claimed in any of claims 7 to 12 in which the pulser comprises a square wave generator arranged to supply a square wave signal to a first transistor (32), the first transistor (32) being switched on when the input square wave is relatively high, the first transistor (32) being electrically connected to a supply voltage (VCC), the first transistor (32) being electrically connected in series to a second transistor (44) via a capacitor (52), the second transistor (44) being electrically connected to the supply voltage (VCC), the second transistor (44) being switched on when the first transistor (32) is switched on to produce the first electrical pulse, the first electrical pulse being supplied from the second transistor (44) to the stress wave sensor (10), the capacitor (52) being charged up to switch off the second transistor (44).

14. An apparatus as claimed in claim 13 in which the first transistor (32) is switched off when the input square wave is relatively low, the first transistor (32) producing the second electrical pulse which is supplied to the stress wave sensor (10) via a second capacitor (64), a diode (70) being arranged to set the predetermined amplitude of the second electrical pulse.

Patentansprüche

1. Verfahren zum Prüfen des Ansprechens eines Spannungswellensensors (10), der einen Wandler (12) und einen hiermit in Reihe liegenden Verstärker (20) aufweist, wobei der Sensor (10) an einer Stelle elektrisch zwischen dem Wandler (12) und dem Verstärker (20) mit elektrischen Impulsen beaufschlagt wird, dadurch gekennzeichnet, daß wenigstens ein elektrischer Impuls (60) mit einer relativ großen Amplitude derart zugeführt wird, daß ein betriebsbereiter Wandler (12) zu Schwingungen angeregt wird, wobei der betriebsbereite Wandler (12) zu einer Schwingung durch wenigstens einen ersten elektrischen Impuls veranlaßt wird, der einen zusätzlichen elektrischen Impuls erzeugt, daß der erste elektrische Impuls und irgendein zusätzlicher elektrischer Impuls, der durch den Wandler (12) erzeugt wird, dem Verstärker (20) zugeführt werden, wobei der betriebsbereite Verstärker (20) den zugeführten ersten elektrischen Impuls und jeden zusätzlichen elektrischen Impuls verstärkt, um ein Ausgangssignal (64) zu erzeugen, daß aus dem Ausgangssignal (64) des Verstärkers (20) bestimmt wird, ob irgendeiner oder mehrere von Wandler (12) und Verstärker (20) nicht zufriedenstellend arbeiten, wobei ein nicht betriebsbereiter Verstärker (20) den zugeführten ersten elektrischen Impuls und alle zusätzlichen elektrischen Impulse nicht verstärkt und kein Ausgangssignal erzeugt, wobei das Fehlen eines Ausgangssignals vom Verstärker (20) anzeigt, daß der Verstärker (20) nicht betriebsbereit ist, daß ein zweiter elektrischer Impuls 62 dem Sensor (10) an der Stelle elektrisch zwischen dem Wandler (12) und dem Verstärker (20) zugeführt wird, wobei der zweite elektrische Impuls (62) eine relativ kleine vorbestimmte Amplitude derart aufweist, daß der Verstärker (20) nicht gesättigt wird, daß der zweite elektrische Impuls (62) dem Verstärker (20) zugeführt wird und daß aus dem Ausgangssignal (70) des Verstärkers (20) entsprechend dem zweiten elektrischen Impuls (62) der Verstärkungsgrad des Verstärkers (20) festgestellt wird.

2. Verfahren zur Prüfung des Ansprechens eines Spannungswellensensors nach Anspruch 1, bei welchem der Verstärkungsgrad des Verstärkers

(20) eingestellt wird, wenn das Ausgangssignal (70) des Verstärkers (20) entsprechend dem zweiten elektrischen Impuls (62) anzeigt, daß der Verstärkungsgrad des Verstärkers (20 niedriger als ein vorbestimmter Wert ist.

3. Verfahren zur Prüfung des Ansprechens eines Spannungswellensensors nach Anspruch 1 oder 2, bei welchem der Verstärkungsgrad des Verstärkers (20) eingestellt wird, wenn das Ausgangssignal (64) des Verstärkers (20) entsprechend dem ersten elektrischen Impuls (60) anzeigt, daß die Empfindlichkeit des Wandlers (12) abgefallen ist.

4. Verfahren zur Prüfung des Ansprechens eines Spannungswellensensors nach einem der Ansprüche 1 bis 3, bei welchem die Ausgangssignale (64, 70) mit einer Hüllkurve versehen werden.

5. Verfahren zur Prüfung des Ansprechens eines Spannungswellensensors nach Anspruch 4, bei welchem die Spitzenamplitude des umhüllten Ausgangssignals (70) des Verstärkers (20) entsprechend dem zweiten elektrischen Impuls (62) gemessen wird.

6. Verfahren zur Prüfung des Ansprechens eines Spannungswellensensors nach den Ansprüchen 3 oder 4, bei welchem die Fläche unter dem umhüllten Ausgangssignal (64) des Verstärkers (20) entsprechend dem zusätzlichen elektrischen Impuls (60) gemessen wird.

7. Vorrichtung zur Prüfung des Ansprechens eines Spannungswellensensors (10), der einen Wandler (12) und einen elektrisch hiermit in Reihe geschalteten Verstärker (20) aufweist, mit einem Impulsgeber (24), der elektrisch an den Spannungswellensensor (10) an einer Stelle angeschlossen ist, die elektrisch zwischen dem Wandler (12) und dem Verstärker (20) liegt, wobei der Impulsgeber (24) elektrische Impulse dem Spannungswellensensor (10) liefert,
dadurch gekennzeichnet, daß der Impulsgeber (24) wenigstens einen ersten elektrischen Impuls relativ großer Amplitude liefert, derart, daß dieser einen betriebsfähigen Wandler (12) zur Schwingung anregt, wobei der betriebsfähige Wandler (12) durch wenigstens einen elektrischen Impuls zu Schwingungen angeregt wird, der einen zusätzlichen elektrischen Impuls erzeugt, daß der zugeführte erste elektrische Impuls und der zusätzliche elektrische Impuls, der vom Wandler (12) erzeugt wird, dem Verstärker (20) zugeführt werden, wobei ein betriebsfähiger Verstärker (20) den zugeführten elektri- schen Impuls und die zusätzlichen elektrischen Impulse verstärkt, um ein Ausgangssignal zu erzeugen, daß Mittel vorgesehen sind, um aus dem Ausgangssignal des Verstärkers (20) zu bestimmen, ob der Wandler (12) oder der Verstärker (20) oder beide nicht zufriedenstellend arbeiten, daß der nicht betriebsfähige Verstärker (20) den zugeführten elektrischen Impuls und irgendwelche zusätzlichen elektrischen Impulse nicht verstärkt und kein Ausgangssignal erzeugt, wobei das Fehlen eines Ausgangssignals vom Verstärker (20) anzeigt, daß der Verstärker (20) nicht betriebsfähig ist, daß der Impulsgeber (24) wenigstens einen zweiten elektrischen Impuls relativ kleiner vorbestimmter Amplitude liefert, derart, daß der Verstärker (20) nicht gesättigt wird, wobei der zweite elektrische Impuls dem Verstärker (20) zugeführt wird, und daß Mittel vorgesehen sind, um aus dem Ausgangssignal des Verstärkers (20) entsprechend dem zweiten elektrischen Impuls den Verstärkungsgrad des Verstärkers (20) zu bestimmen.

8. Vorrichtung nach Anspruch 7, bei der Mittel vorgesehen sind, um den Verstärkungsgrad des Verstärkers einzustellen, und um den Verstärkungsgrad des Verstärkers (20) zu erhöhen, wenn die Mittel zur Bestimmung des Verstärkungsgrades des Verstärkers aus dem Ausgangssignal des Verstärkers (20) entsprechend dem zweiten elektrischen Impuls anzeigen, daß der Verstärkungsgrad des Verstärkers (20) einen vorbestimmten Wert unterschritten hat.

9. Vorrichtung nach Anspruch 8, bei welcher die Mittel zur Einstellung des Verstärkungsgrades des Verstärkers so ausgebildet sind, daß der Verstärkungsgrad des Verstärkers (20) erhöht wird, wenn die Mittel zur Bestimmung eines Fehlverhaltens von Wandler und Verstärker eine Verminderung der Empfindlichkeit des Wandlers (12) anzeigen.

10. Vorrichtung nach einem der Ansprüche 7 bis 9, bei welcher ein Prozessor eine Umhüllung der Ausgangssignale bewirkt.

11. Vorrichtung nach Anspruch 10, bei welcher der Prozessor die Spitzenamplitude des umhüllten Ausgangssignals des Verstärkers entsprechend dem zweiten elektrischen Impuls mißt.

12. Vorrichtung nach den Ansprüchen 10 oder 11, bei welcher der Prozessor die Fläche unter dem umhüllten Ausgangssignal bes Verstärkers entsprechend dem zusätzlichen elektrischen Impuls mißt.

13. Vorrichtung nach einem der Ansprüche 7 bis 12,

bei welcher der Impulsgeber ein Rechteckwellengenerator ist, der ein Rechteckwellensignal einem ersten Transistor (32) liefert, wobei der erste Transistor (32) angeschaltet wird, wenn die Eingangsrechteckwelle relativ hoch ist, und wobei der erste Transistor (32) elektrisch mit der Speisespannung (VCC) verbunden ist und elektrisch in Reihe an einen zweiten Transistor (44) über einen Kondensator (52) angeschlossen ist, und der zweite Transistor (44) elektrisch mit der Speisespannung (VCC) verbunden ist und angeschaltet wird, wenn der erste Transistor (32) angeschaltet wird, um den ersten elektrischen Impuls zu erzeugen, und wobei der erste elektrische Impuls von dem zweiten Transistor (44) dem Spannungswellensensor (10) geliefert wird und der Kondensator (52) aufgeladen wird, um den zweiten Transistor (44) abzuschalten.

14. Vorrichtung nach Anspruch 13, bei welcher der erste Transistor (32) abgeschaltet wird, wenn die Eingangsrechteckwelle relativ niedrig ist, und der erste Transistor (32) den zweiten elektrischen Impuls erzeugt, der dem Spannungswellensensor (10) über einen zweiten Kondensator (64) zugeführt wird, und wobei eine Diode (70) angeordnet ist, um die vorbestimmte Amplitude des zweiten elektrischen Impulses einzustellen.

Revendications

1. Procédé pour tester la réponse d'un capteur d'ondes de contrainte, le capteur (10) d'ondes de contrainte comprenant un transducteur (12) et un amplificateur (20) disposés électriquement en série, le procédé comprenant l'étape de fournir au capteur (10), en un point situé électriquement entre le transducteur (12) et l'amplificateur (14) des impulsions électriques, caractérisé en ce qu'au moins une première impulsion électrique (60), ayant une amplitude relativement grande, est fournie de façon qu'elle fasse osciller le transducteur (12) lorsqu'il fonctionne, le transducteur (12) en fonctionnement, qui a été mis en oscillation par la au moins une première impulsion électrique générant une impulsion électrique supplémentaire, ledit procédé comprenant les étapes suivantes :
- fournir à l'amplificateur (20) la première impulsion électrique et toute impulsion électrique supplémentaire générée par le transducteur (12), l'amplificateur (20), lorsqu'il fonctionne, amplifiant la première impulsion électrique fournie et toute impulsion électrique supplémentaire, pour produire un signal de sortie (64),
- déteminer à partir du signal de sortie (64) de l'amplificateur (20), si un ou plusieurs du transducteur (12) et l'amplificateur (20) ne fonctionne pas de façon satisfaisante, l'amplificateur (20), lorsqu'il ne fonctionne pas, n'amplifiant pas la première impulsion électrique fournie et toute impulsion électrique supplémentaire, et ne produisant pas un signal de sortie, l'absence de signal de sortie en provenance de l'amplificateur (20) indiquant que l'amplificateur (20) ne fonctionne pas,
- fournir une deuxième impulsion électrique (62) au capteur (10) au point situé électriquement entre le transducteur (12) et l'amplicateur (20), la deuxième impulsion électrique (62) étant d'amplitude prédéterminée relativement petite, de façon qu'elle ne sature pas l'amplificateur (20),
- fournir la deuxième impulsion électrique (62) à l'amplificateur (20), et
- déterminer à partir du signal de sortie (70) de l'amplificateur (20) correspondant à la deuxième impulsion électrique (62), le gain de l'amplificateur (20).

2. Procédé pour tester la réponse d'un capteur d'ondes de contrainte selon la revendication 1, dans lequel le gain de l'amplicateur (20) est ajusté lorsque le signal de sortie (70) de l'amplificateur (20), correspondant à la deuxième impulsion électrique (62), indique que le gain de l'amplificateur (20) est inférieur à une valeur prédéterminée.

3. Procédé pour tester la réponse d'un capteur d'ondes de contrainte selon la revendication 1 ou la revendication 2, dans lequel le gain de l'amplificateur (20) est réglé lorsque le signal de sortie (64) de l'amplificateur (20), correspondant à la première impulsion électrique (60), indique que la sensibilité du transducteur (12) a diminué.

4. Procédé pour tester la réponse d'un capteur d'ondes de contrainte selon l'une quelconque des revendications l à 3, dans lequel les signaux de sortie (64, 70) sont enveloppés.

5. Procédé pour tester la réponse d'un capteur d'ondes de contrainte selon la revendication 4, dans lequel l'amplitude de pointe du signal de sortie enveloppé (70) de l'amplificateur (20), correspondant à la deuxième impulsion électrique (62), est mesurée.

6. Procédé pour tester la réponse d'un capteur d'ondes de contrainte selon la revendication 3 ou la revendication 4, dans lequel la surface sous le signal de sortie enveloppé (64) de l'amplificateur (20), correspondant à l'impulsion électrique sup-

plémentaire (60), est mesurée.

7. Dispositif pour tester la réponse d'un capteur d'ondes de contrainte (10), le capteur d'onde de contrainte (10) comprenant un transducteur (12) et un amplificateur (20), disposés électriquement en série, le dispositif comportant un générateur d'impulsion (24) disposé pour être connecté électriquement au capteur d'ondes de contrainte (10), en un point situé électriquement entre le transducteur (12) et l'amplificateur (20), le générateur d'impulsion (24) étant prévu pour fournir des impulsions électriques au capteur (10) d'ondes de contrainte, caractérisé en ce que le générateur d'impulsion (24) est prévu pour fournir au moins une première impulsion électrique d'amplitude relativement grande, de façon qu'elle fasse osciller le transducteur (12) lorsqu'il est en fonctionnement, le transducteur (12) en fonctionnement est mis en oscillation par la au moins une impulsion électrique en générant une impulsion électrique supplémentaire, la première impulsion électrique fournie et toute impulsion électrique supplémentaire générée par le transducteur (12) étant fournie à l'amplificateur (20), l'amplificateur (20) en fonctionnement amplifiant l'impulsion électrique fournie et l'impulsion électrique supplémentaire pour produire un signal de sortie, des moyens pour déterminer à partir du signal de sortie de l'amplificateur (20) si un ou plusieurs du transducteur (12) et de l'amplificateur (20) ne fonctionne pas correctement, l'amplificateur (20), lorsqu'il ne fonctionne pas n'amplifiant pas l'impulsion électrique fournie et toute impulsion électrique supplémentaire, et ne produisant pas un signal de sortie, l'absence de signal de sortie provenant de l'amplificateur (20) indiquant que l'amplificateur (20) ne fonctionne pas, le générateur d'impulsion (24) est conçu pour fournir au moins une deuxième impulsion électrique d'amplitude prédéterminée relativement petite, de façon qu'elle ne sature pas l'amplificateur (20), la deuxième impulsion électrique étant fournie à l'amplificateur (20), et le dispositif comporte en outre des moyens pour déterminer le gain de l'amplificateur (20) à partir du signal de sortie de l'amplificateur (20) correspondant à la deuxième impulsion électrique.

8. Dispositif selon la revendication 7, dans lequel un moyen pour régler le gain de l'amplificateur est prévu pour augmenter le gain de l'amplificateur (20) lorque les moyens pour déterminer le gain de l'amplificateur à partir du signal de sortie de l'amplificateur (20) correspondant à la deuxième impulsion électrique, indiquent que le gain de l'amplificateur (20) est inférieur à une valeur prédéterminée.

9. Dispositif selon la revendication 8, dans lequel les moyens pour ajuster le gain de l'amplificateur sont conçus pour augmenter le gain de l'amplificateur (60) lorsque les moyens pour déterminer si un ou plusieurs du transducteur et de l'amplificateur ne fonctionne pas correctement, indiquent que la sensiblité du transducteur 12 a diminué.

10. Dispositif selon l'une quelconque des revedications 7 à 9, dans lequel un processeur envelope les signaux de sortie.

11. Dispositif selon la revendication 10, dans lequel le processeur mesure l'amplitude de pointe du signal de sortie enveloppé de l'amplificateur, correspondant à la deuxième impulsion électrique.

12. Dispositif selon les revendications 10 ou 11, dans lequel le processeur mesure la surface sous le signal de sortie enveloppé de l'amplificateur qui correspond à l'impulsion électrique supplémentaire.

13. Dispositif selon l'une quelconque des revedications 7 à 12, dans lequel le générateur d'impulsion comporte un générateur d'onde de contrainte carrée conçu pour fournir un signal d'onde carrée à un premier transistor (32), le premier transistor (32) étant activé lorsque l'onde carrée d'entrée est relativement haute, le premier transistor (32) étant connecté électriquemet à une tension d'alimentation (VCC), le premier transistor (32) étant électriquement connecté en série à un deuxième transistor (44) par l'intermédiaire d'une capacité (52), le deuxième transistor (44) étant connecté électriquement à la tension d'alimentation (VCC), le deuxième transistor (44) étant activé lorsque le premier transistor (32) est activé pour produire la première impulsion électrique, la première impulsion électrique étant fournie à partir du deuxième transistor (44) au capteur d'onde de contrainte (10), la capacité (52) étant chargée pour désactiver le deuxième transistor (44).

14. Dispositif selon la revendication 13, dans lequel le premier transistor (32) est désactivé lorsque l'onde carré d'entrée est relativement basse, le premier transistor (32) produisant la deuxième impulsion électrique qui est fournie au capteur d'onde de contrainte (10) par l'intermédiaire d'une deuxième capacité (64), une diode (70) étant disposée pour régler l'amplitude prédéterminée de la deuxième impulsion électrique.

Fig.1.

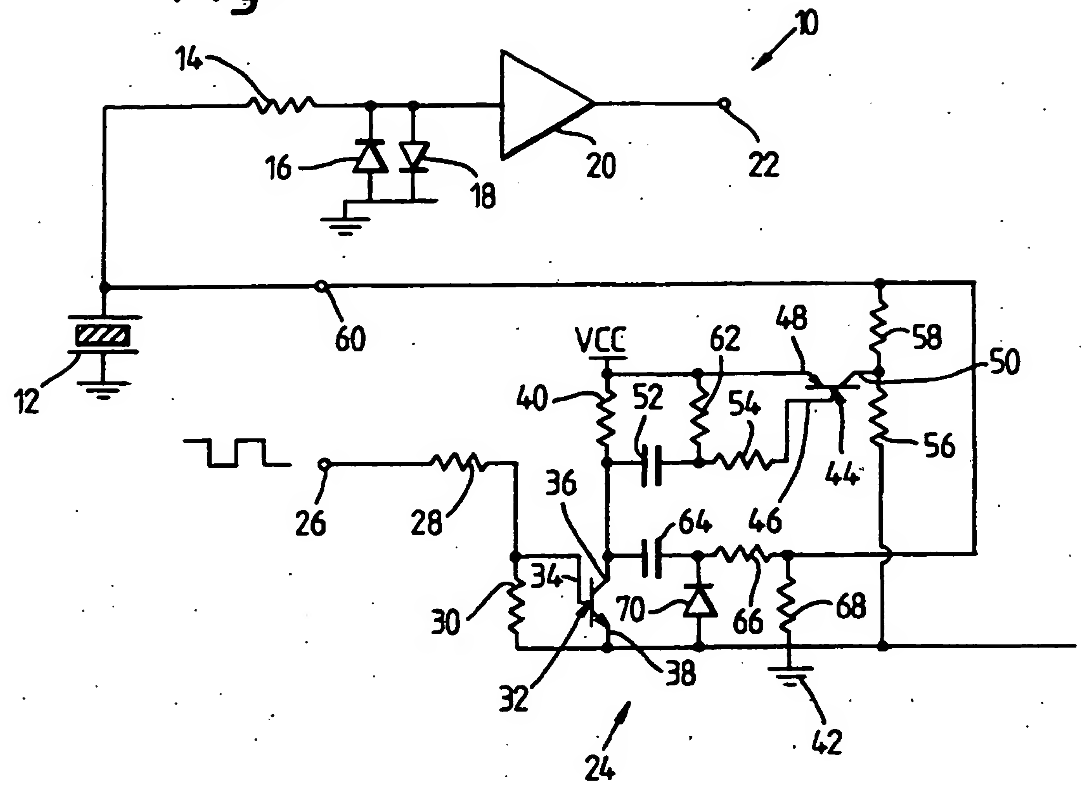
10
14
16
18
20
22
12
60
VCC
62
48
58
50
40
52
54
56
44
26
28
36
64
46
34
30
70
66
68
32
38
42
24

Fig.6.

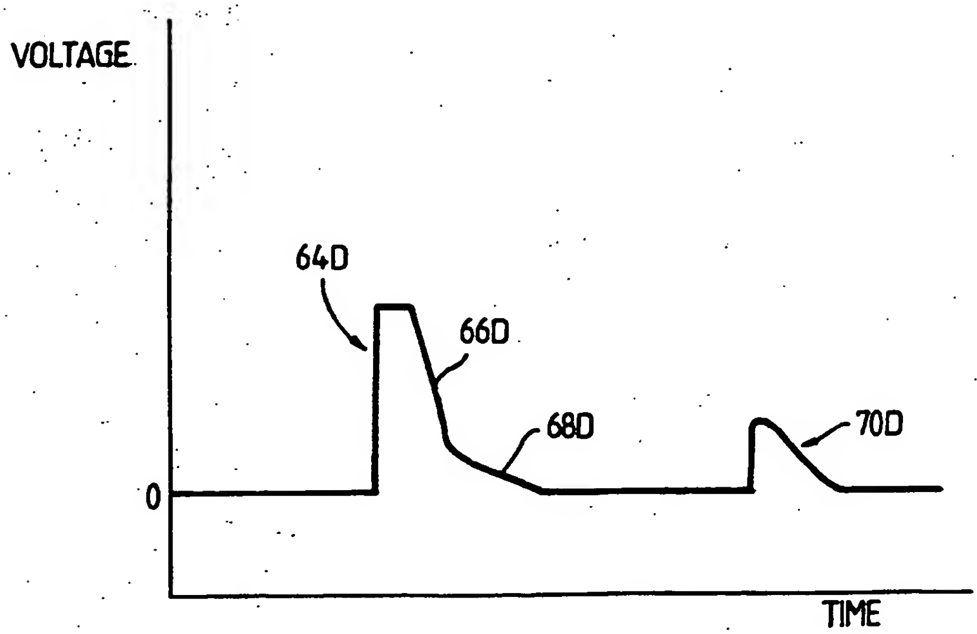
VOLTAGE
64D
66D
68D
70D
0
TIME

Fig.2.

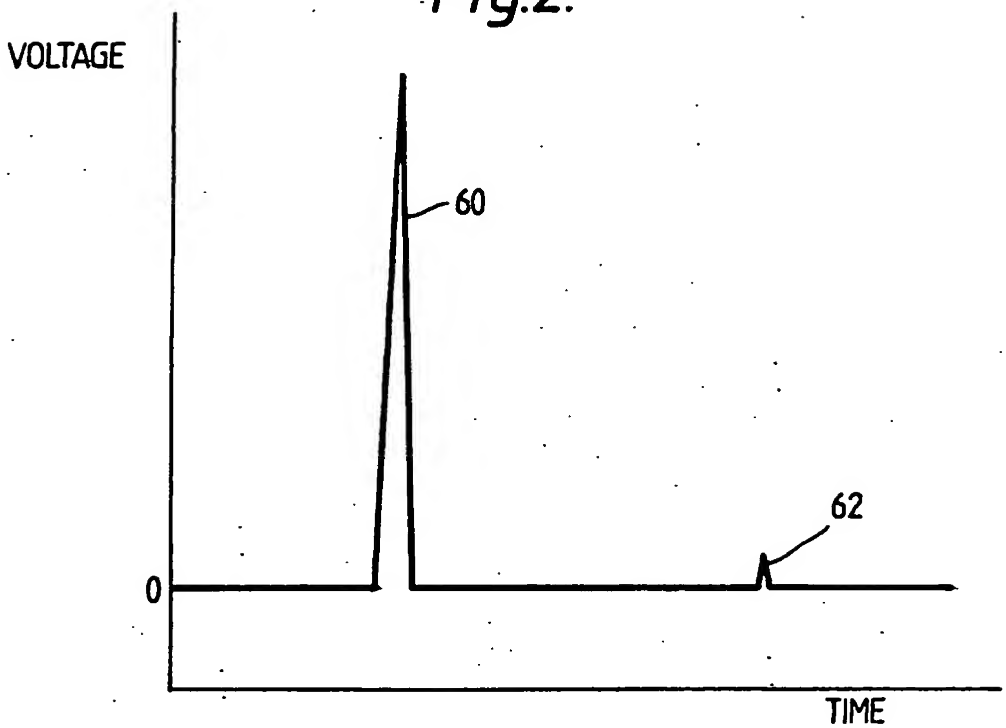

Fig.3.

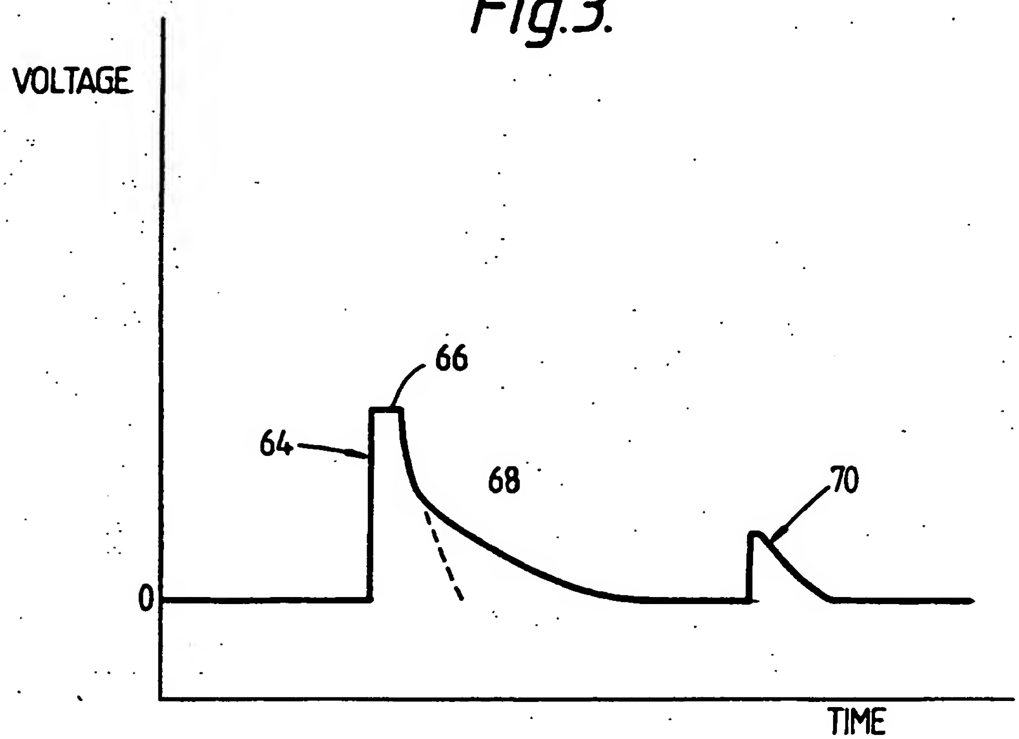

Fig.4.

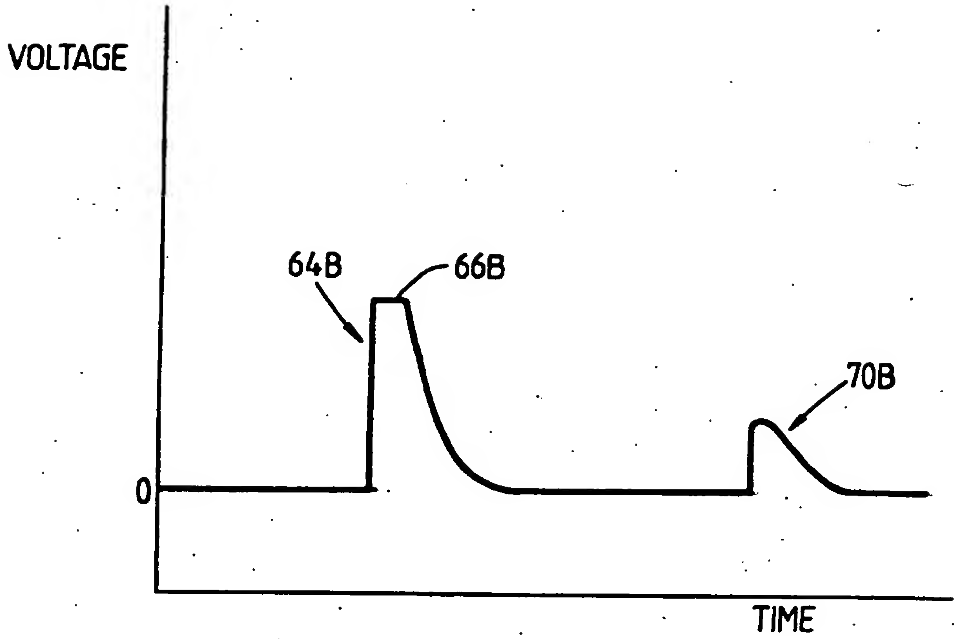

Fig.5.